

# Pollen study of Cranberry Pond, near Emporia, Madison county, Indiana

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# Butler University Botanical Studies

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Ray C. Friesner

The *Butler University Botanical Studies* journal was published by the Botany Department of Butler University, Indianapolis, Indiana, from 1929 to 1964. The scientific journal featured original papers primarily on plant ecology, taxonomy, and microbiology. The papers contain valuable historical studies, especially floristic surveys that document Indiana's vegetation in past decades. Authors were Butler faculty, current and former master's degree students and undergraduates, and other Indiana botanists. The journal was started by Stanley Cain, noted conservation biologist, and edited through most of its years of production by Ray C. Friesner, Butler's first botanist and founder of the department in 1919. The journal was distributed to learned societies and libraries through exchange.

During the years of the journal's publication, the Butler University Botany Department had an active program of research and student training. 201 bachelor's degrees and 75 master's degrees in Botany were conferred during this period. Thirty-five of these graduates went on to earn doctorates at other institutions.

The Botany Department attracted many notable faculty members and students. Distinguished faculty, in addition to Cain and Friesner, included John E. Potzger, a forest ecologist and palynologist, Willard Nelson Clute, co-founder of the American Fern Society, Marion T. Hall, former director of the Morton Arboretum, C. Mervin Palmer, Rex Webster, and John Pelton. Some of the former undergraduate and master's students who made active contributions to the fields of botany and ecology include Dwight W. Billings, Fay Kenoyer Daily, William A. Daily, Rexford Daudenmire, Francis Hueber, Frank McCormick, Scott McCoy, Robert Petty, Potzger, Helene Starcs, and Theodore Sperry. Cain, Daudenmire, Potzger, and Billings served as Presidents of the Ecological Society of America.

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# POLLEN STUDY OF CRANBERRY POND NEAR EMPORIA, MADISON COUNTY, INDIANA<sup>1</sup>

By JEAN BARNETT

This paper is one of a series of fossil pollen studies carried on in the Botany Department of Butler University. In this work peat was collected from a number of bogs distributed over the northern half of the state. One of these is Cranberry pond near Emporia, Madison county, Indiana.

The modern flora of Indiana as a whole is that of a mesophytic deciduous forest. Interspersed within the present forest areas are to be found numerous relic colonies of former vegetational climaxes. These relic colonies are of two main types, viz., prairie relics of grassland species and boreal relics of northern species. In so far as the present study is concerned, only the tree members of the latter type of relic colony are of importance. These consist of such trees as hemlock, white pine, tamarack and arbor vitæ. It is well known that the modern range for these trees is farth north of Indiana, especially northern to the present-day colonies found in the state. The presence of these trees in Indiana so far south of their modern range indicates that at one time Indiana had a very different floral aspect. Perhaps these so-called relic species, along with other boreal plants, were once the dominant species, and the present-day climax associations which we now find so common were unknown in this region. Such is the hypothesis that is proposed on the strehgth of the results of this series of fossil pollen examinations.

In the present study, pollen analysis has been mainly concerned with tree pollen, not only because the trees form the dominant vegetation and because of its abundance, but also because it gives the most direct indices to past climates and of postglacial vegetation (Godwin, 8).

## BOGS AND THEIR FORMATION

According to Potzger (16), a bog is a definite life association or "biome," which results in the formation of a specific type of soil. In the writer's opinion, this seems to be a very accurate description. This specific soil formation may be above the surface, where mass accumulation results

<sup>1</sup>This paper is a portion of a thesis in partial fulfillment of the requirements for the degree of Master of Arts in Butler University.

in a building up of vegetation as in the high moors of Europe, or below the surface in depression areas where drainage is poor. This last named is the common condition in North America.

The typical bog in Indiana is of "kettle hole" origin. These usually developed from the melting block of ice which had been buried in the drift as the ice retreated (Cleland, 3). When the block of ice melts, a small kettle lake is formed, sphagnum moss comes into the lake and the life cycle of a bog has begun. In glaciated regions, bogs of all stages can be found. Some lakes have merely boggy borders, where the accumulated vegetable deposits have begun the work of filling, others are nearly or quite filled; often only a small pool is left in the center showing where the last of the filling-in process is in progress. Cranberry pond is evidently a very old bog, as it is completely filled.

Most bogs have marl deposits in their lower levels. In the present series of investigations at Butler University, these marl deposits vary in depth from one to twelve feet. According to Smith (19), the deposition of marl is due to the action of several *Cyanophyceæ*.

Many writers hold that the acidity of the water and peat is a feature of a typical bog, but Potzger (16) has found that this is not necessarily true with all bogs. The reaction may be acid or alkaline. Cranberry pond gave an acid reaction, but a bog examined near Logansport, Indiana, gave a nearly neutral reaction.

Fossils of both plant and animal remains are found in these peat deposits. Potzger (17) reports the finding of a set of mastodon tusks and deer and elk antlers, as well as logs of *Thuja* and *Larix*, in the upper Blue river valley in Henry county, Indiana, an area only twelve miles east of the Emporia bog. So well preserved, also, is much of the vegetation present in bogs, that it has been possible to separate out the twigs and leaves of different plants and definitely identify them. In this way, plants that inhabited the bog many thousands of years ago have been discovered, and we find for the most part that the pollen grains are in perfect condition, almost exactly resembling those of our modern trees.

## LOCATION, TOPOGRAPHY AND VEGETATIONAL FEATURES

Cranberry pond, the bog under consideration in this paper, is located in the southeast corner of Madison county, about a half-mile south of the little town of Emporia and just east of the Big Four railroad tracks. Madison county is located in the central part of Indiana, northeast of Indianapolis. This region is a part of the Tipton Till Plain, having been

traversed by both the Illinoian and Early Wisconsin ice sheets. It is a region covered by glacial till of nearly level surface, with few lakes and dissecting streams (Welch, 22). The surface of Madison county in general consists of a gently undulating plain, with broad, level, interstream areas, more or less rolling as they near the water courses (Avon Burke and Ruhlen, 2).

The bog occupies approximately fifteen acres and is surrounded by a relatively flat tableland of fertile soil. Just south and southeast of the bog is a woodlot of deciduous trees. The bog is at present covered chiefly with *Typha* and *Calamagrostis*. Scattered clumps of *Osmunda regalis spectabilis* are still to found and *Rhus vernix* is to be found on the east side. Formerly a considerable number of cranberry plants were present, according to Miss Rosa Markle, who has lived on the farm where the bog is located since 1870, but recent fires have completely destroyed them.

## METHODS

Two borings were made in the bog by means of a peat borer of the cylinder type with a movable sleeve. The first hole was in the north-central portion and was made twenty-one feet in depth. The second boring was about fifty yards southwest of the first and reached a depth of thirty-two feet. The latter boring was approximately the center of the bog.

Samples were taken at each foot-level from the surface to the bottom, which was indicated by the presence of sand and gravel. To avoid contamination, the borer was carefully washed at each descent and care was taken to be sure that each sample came from the center of the core and had not touched the sides of the chamber. The sample was immediately placed into a small glass bottle and stoppered. Contamination of the sample by pollen of the air was avoided, as the borings were made in October. Upon reaching the laboratory, the bottles were sealed with paraffin to prevent drying out.

By means of the Youden hydrogen-ion apparatus, the pH for each foot-level in both borings was taken. Two readings for each level were made and from the average active acidity the pH for the level was determined.

In the preparation of the peat samples for identification, the method for separation of fossil pollen from peat recommended by Geisler (6) was used with a few variations. This method was chosen over the alkali treatment used by Sears (18) and the treatment recommended by G. Erdtman and H. Erdtman (4) as it seemed to be more efficient and

less apt to introduce error by destruction of fragile pollen grains and distorting of conifer pollen by breakage of wings. Two hundred pollen grains were counted for each level and the percentage for each genus was computed. For accurate results Sears (18) says it is better to count not less than 100 grains, and Potzger (15) found no great percentage difference between 100 and 200 grain-counts.

Identification was based upon the descriptions and diagrams of Sears (18), descriptions and diagrams of Wodehouse (23), and upon slides made from pollen grains of modern trees. The conifers, *Abies*, *Picea* and *Pinus* were distinguished chiefly by size differences, and the rest by their pores, furrows and surface markings, as well as size differences. Slides for each level were finally examined to determine stratification of the bog and this was recorded in graph form in Figure 1.

## HYDROGEN-ION REACTIONS

The acidity readings at comparable levels are remarkably close in the two borings. The first foot-level in each boring was barely above pH 6.0. In the second foot the reaction drops to pH 5.6 and 5.87 respectively. The reaction in Spectrum A begins rising in the third foot, while that in Spectrum B does not begin a definite rise until the fifth foot. The rise continues until the eighth foot in Spectrum A and the twelfth foot in Spectrum B. From these levels the reactions vary little until the twenty-sixth foot in Spectrum A and the eighteenth foot in Spectrum B. At these levels a sudden rise to above pH 7.0 is found. Both spectra yield alkaline readings from these levels until the lowest levels are reached, Spectrum A ending at the 32-foot level with pH 7.97 and Spectrum B ending at the 21-foot level with pH 7.7.

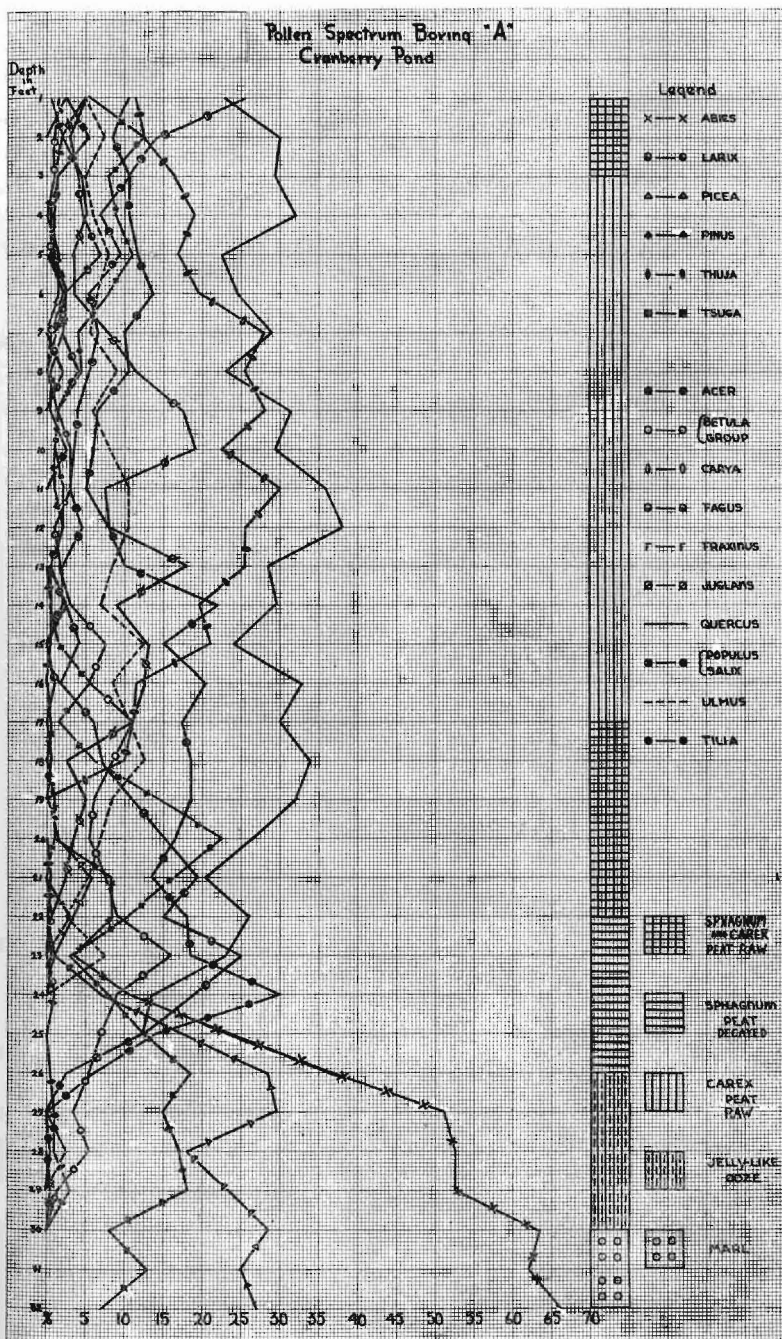
## POLLEN DETERMINATIONS

Two hundred pollen grains were determined in each foot-level for both borings. Percentages for each genus are given for Spectrum A in Figure 1. From these determinations we find that *Abies* and *Picea* dominate the lowest levels. These two genera, with a smaller percentage of *Pinus*, dominate until the 24-foot level, when the *Populus-Salix* group and *Larix* surpass them. Broad-leaved trees make their appearance in small numbers at the 29-foot level, with the *Betula* group in the majority.

*Quercus* and *Larix* control the spectrum at the 23-foot level; *Carya* comes into prominence at the 15-foot level, while near the surface *Carya* and *Quercus* control the spectrum.

FIGURE 1

# Pollen Spectrum Boring "A" Cranberry Pond



*Abies* and *Picea* gradually lose out, the former disappearing at the 19-foot level and the latter at the 17-foot level. *Pinus* is the only genus found throughout the entire spectrum. It reaches a maximum of 22.5 per cent in the 20-foot level, decreases until near the surface, where it rises again to 12.5 per cent at the 2-foot level, and ends with 5.5 per cent at the top-level. *Larix* disappears at the 14-foot level and reappears only at the 8-foot level.

*Acer* and *Fagus* make their appearance at the 14-foot level. *Fagus* varies little from there to the top, but *Acer* gradually increases until it reaches 25.5 per cent at the 1-foot level. Here it forms a climax with *Quercus* at the expense of *Carya*. *Ulmus* and *Juglans* are prominent through most of this profile, forming a secondary climax.

A curve of the pollen percentages in Spectrum B would follow roughly that of Spectrum A. The conifers are found nearer the surface in Spectrum B. This may be correlated with the fact that Spectrum B is shallower than A. *Pinus* is found in every foot-level. *Quercus* and *Carya* control from the 14-foot level to the surface, but *Larix* and *Pinus* surpass *Carya* in several levels, with *Carpinus* also exceeding *Carya* in the 9-foot level. *Acer* and *Fagus* appear in the 14-foot level and, as in Spectrum A, *Fagus* remains about the same, while *Acer* gradually increases until it reaches 15.5 per cent at the 1-foot level. *Juglans* and *Ulmus* are prominent in a secondary way in this spectrum as in Spectrum A. Spectrum B differs from A in the absence of any definite dominants in the former. Grass, *Compositæ* pollen and fern spores were not counted, but were observed in various levels.

The stratification in the bog is shown in Figure 1. Marl comprised the bottom two feet and a jelly-like ooze composed the next four feet. This was followed by decomposed *Sphagnum*-peat for the next four feet until the 21-foot level, where a combination of raw *Sphagnum* and *Carex*-peat was found. This persisted until the 16-foot level, where it gave way to raw *Carex*-peat, which continued until the 2-foot level, where raw *Sphagnum* and *Carex*-peat again combined.

## DISCUSSION

Using as a basis the much-quoted statement of Auer (1), "The pollen content of the successive layers of the individual bogs is a direct indication of the comparative abundance of the different trees growing at the time the peat layers were forming," we can say that *Picea* and *Abies* controlled the forests in the vicinity of Emporia at the time the first



layers of peat were being formed in Cranberry pond. Godwin (8) found that winged pollen grains travel greater distances than wind-carried pollen without such appendages. This might, of course, become a source of error in any pollen spectrum and will need to be kept in mind when interpreting horizons exhibiting both types of pollen. But the entire absence of nonwinged pollen below the 24-foot level can leave but one conclusion, viz., that the forests of the surrounding territory were essentially limited to winged-pollen conifers. We must, therefore, classify it as a typical boreal forest.

From the 24-foot level on, the broad-leaved trees, mainly *Quercus* and *Carya*, control the pollen percentages, replacing the conifers, which disappear rapidly, and finally, at the surface, *Acer* becomes dominant at the expense of *Carya*. This succession of trees, shown by the pollen diagram of Cranberry pond, agrees with the results of Auer (1), Sears (18), Potzger (15), Voss (20) and Houdek (10), all of whom have studied regions adjacent to Indiana. Voss (20) states that, "All pollen diagrams indicate that the conifers *Abies* and *Picea* were the first dominant trees to appear on the newly uncovered land. As the climate became warmer and edaphic conditions changed, the oaks, maples, etc., gradually invaded and gradually superseded the conifers on the uplands." This is the succession indicated in the Emporia bog.

If plants are indicators of climate, a cool, dry climate, indicated by *Picea* and *Abies*, was superseded by a warmer, more humid climate, indicated by the deciduous trees. The present-day succession of climaxes from Indiana northward is Beech-Maple in Indiana, *Pinus-Thuja* in the Lake Forest, and *Picea-Abies* in the boreal forest. The same order of succession occurs in this pollen spectrum from the bottom upward or, in time, from early postglacial period to the present. Reconstructing the vegetational picture of Indiana, Michigan and southeastern Canada: the conifers were forced far southward by the glaciers, crowding out or pushing the deciduous trees still farther south; then, as the ice melted and the glacier receded, the conifers followed in their wake, the deciduous trees advancing northward as climate and edaphic conditions became suitable. But here and there over the glaciated area were left patches of conifers, relics of the former conifer climax. These relic colonies occupied spots which presented local conditions sufficiently rigorous, edaphically, to permit them to compete, though in a gradually losing battle, for many centuries, with the invading broad-leaved species. Friesner and Potzger (5) have shown that, in every case, areas occupied

by conifers in the relic colonies at Pine Hills and Trevlac have a more rigorous habitat than adjacent areas occupied by broad-leaved trees. In its ultimate effect, the microclimate in areas adjacent to these bogs remained comparable for many centuries to that of the boreal forest, and later to that of the Lake Forest of today.

The absence of *Thuja* pollen in this bog may be due to the fact that it does not preserve, but rapidly deteriorates in water (Sears 18). The presence of high percentages of *Larix* throughout the center of the bog is readily explained by the fact that it is an early invader of bog surfaces.

The presence of *Pinus* pollen throughout the pollen spectrum and its presence for many centuries after the disappearance of *Picea* and *Abies* is probably indicative of climatic changes from cold dry to warmer moister in so gradual a transition that *Pinus* could compete with broad-leaved species for many centuries before being finally eliminated in the last few centuries before our present time. *Pinus* evidently persisted as a relic until the rather recent past but was finally crowded out by the ever-widening control of the deciduous forest, favored, no doubt, by continued gradual climatic change which finally passed the limits of adaptability for pine.

The postglacial succession of forest vegetation as indicated by pollen analysis of this bog becomes: *Picea-Abies*, *Quercus-Larix-Pinus*, *Quercus-Carya* and *Quercus-Acer*, with *Pinus* occurring throughout the spectrum. The pollen percentages in the top level gives approximately the picture of the vegetation now occurring in the surrounding area.

Spectrum B agrees for the most part with Spectrum A in this order of succession but it does not show climaxes so well defined as in Spectrum A. It was taken nearer the edge, where, no doubt, the bog was filled in sooner. How much the encroaching fringe of shrubs and other marginal vegetation may have interfered with free deposition is unknown. It would appear, at least, that spectra taken from borings in the deepest part of the bog give the most clearly defined picture of vegetational history. A study of the comparative vegetational picture given by a succession of borings from edge to edge of a bog is at present under way in this laboratory.

The stratification of the bog shows that the bottom is sand, suggesting a former lake of glacial origin. The next two levels are marl, suggesting the presence of *Chara* or various *Cyanophyceæ* in an open water stage. This marl explains the alkalinity of the lower levels. The four feet of ooze on top of the marl suggests deposition under water. The next four feet are decomposed *Sphagnum*, indicating that *Sphagnum* was an early

inhabitant of the bog and suggesting deposition from the bottom of a floating mat. From the decayed Sphagnum to the surface is found raw Sphagnum and Carex, showing that deterioration was not complete and that Carex entered the bog later in its history. The absence of Sphagnum on the surface of the bog is correlated with the disappearance of such other boreal species as cranberry. These were destroyed by fire about fifteen years ago.

## SUMMARY

1. Pollen analysis of peat and marl obtained from two borings in the Cranberry pond bog near Emporia, Madison county, Indiana, show that *Picea* and *Abies* are dominant from 31-foot to 24-foot levels. These are replaced by deciduous genera, which dominate to the surface.

2. The order of succession has been: *Picea-Abies*, *Quercus-Larix-Pinus*, *Quercus-Carya* and *Quercus-Acer*.

3. *Pinus* occurs throughout the bog spectrum, persisting to within a few centuries of the present, but was not present when early settlers entered the territory.

4. Four main layers were found in the spectrum, viz., two feet of marl, four feet of ooze, four feet of finely disintegrated Sphagnum, with the upper 22 feet of raw Sphagnum and Carex mixed or raw Sphagnum,

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